Proper site management important in today's competitive marketplace

*by **Brent Tessmann***
Product Service Manager, Americas
Bently Nevada Corporation
and
Tom Pfoh
Corporate Product Service Manager
Bently Nevada Corporation

Access to machinery condition information is essential to a company's success in today's competitive marketplace. Without machinery condition information, unscheduled or extended downtime can result.

For a machinery management program to achieve its goals, the information must be valid. This includes vibration, position, bearing and oil temperature information as well as process information, which is such an important part of the program. In addition, the basic machinery protection system must also be in excellent working condition.

There are four ways to ensure that these conditions are met:

1. Determine which data is required.
2. Install the instrumentation properly.
3. Ensure proper maintenance checks are performed.
4. Repair instrumentation promptly and correctly.

Determining what data is needed

The type of data that is required will depend on many factors including machine construction, application, importance to process, etc. For example, a machine with fluid-film bearings requires shaft vibration data obtained by proximity probes rather than bearing housing vibration data. And bearing temperature data, along with the vibration information, may give a more complete picture of the machine's condition. Our Sales Engineers and Machinery Diagnostic Services Engineers can assist in determining the appropriate measurements for your machinery. If the necessary transducers do not exist, however, they must be installed.

Proper installation

There are many factors to consider when installing transducers in order to ensure that they provide accurate data and have a long service life. These factors typically involve locating the transducer at the appropriate point for the measurement, mounting the transducer properly, and meeting the requirements of the physical limitations of the transducer. Our Design & Installation Services department has experience installing thousands of transducers in a wide range of applications.

Process data can be particularly helpful in evaluating machinery condition. The process data, however, must be combined with machinery data to be most effective. If the process data is available on a plant information or control network, a hardware and software communications link between the plant and machinery management systems must be established. This data can then be "integrated" to provide a better indication of machinery health. (See the article on page 20).

Performing proper maintenance

Once a system is properly installed and configured, it must be maintained to ensure proper operation. On a routine basis, the calibration and operation of the transducers, monitors, and machinery management system must be checked. To accomplish this, a technician must be knowledgeable about all aspects of system operation. In addition, it is important that the technician understands the data acquisition and data presentation aspects of the machinery diagnosis part of the management system. If a set of XY probes is mounted correctly, for example, but connected backwards, the data they provide can lead a machinery engineer to the incorrect conclusion about a machine's condition.

Prompt and correct repairs

If a failure occurs, it is important to promptly and correctly repair the system. This helps ensure that valuable data is not lost or unavailable when it is absolutely necessary to diagnose a machine malfunction. To do this, the technician must be familiar with the operation of the system down to the failed device level. Once the failed device is identified, the replacement part must be in stock to complete the repair.

Site Management Agreements

To ensure that systems are maintained and repaired properly, Bently Nevada offers Site Management Agreements. The goal of these agreements is to create a well-managed machinery management program that will reduce maintenance costs and catastrophic failures, increase machine availability, and extend machinery life.

The first step of the agreement is to make sure that the existing machinery protection system is operating correctly and can be relied upon. Bently Nevada's Product Service organization provides complete system checkouts and verification services to ensure the integrity of a system's operation.

During a system checkout, all required configuration updates and adjustments are made, so it will provide trouble-free operation. Once the system is providing accurate and reliable data, it will be remotely accessed to ensure the continued reliability of the system's hardware and software components. Computer-based machinery management systems provide faster response times to potential problems at a much lower cost than a site visit. As part of a Site Management Agreement, these services are scheduled on a regular basis and are included as part of a comprehensive management package.

Detailed reports are also provided at regular intervals to explain any corrective actions taken and any pending actions. In accordance with governmental regulations, any changes made to the machinery management system are documented along with alarm setpoints, calibration information, and serial numbers.

Having Bently Nevada perform the instrumentation maintenance as part of a site management program reduces your costs and increases the dependability of your machinery management system. Bently Nevada's Service organizations will perform any necessary maintenance and advise your personnel of the actions taken, in writing.

Our Machinery Diagnostic Services organization is part of a complete Site Management Agreement. Facilities with machinery management systems that are equipped with remote telecommunications can contact a qualified engineer, 24 hours a day, for advice on possible machinery problems. Upcoming Orbit articles will discuss our products' remote machinery diagnostic capabilities.

Continued from page 17 (Some realities of field balancing).

Dynamic Stiffness

Dynamic stiffness is the restraint of motion when a mechanical system is subjected to an oscillating or rotating force. This can be expressed in the general equation ***Motion = Force/Restraint.*** Dynamic stiffness is the sum of the stiffnesses associated with each of the physical characteristics of a system: spring, damping, and mass. Each of these stiffnesses results in a characteristic **lag** in the response of the system with respect to the applied force. This is most easily seen in the classical, one-dimensional spring-damper-mass model, (Figure 1).

In the rotating, two-dimensional rotor/bearing/seal system (Figure 2) each stiffness component, including that of the surrounding fluid, results in a distinct **direction** of response. The direction is associated with the phase lags seen in the one-dimensional case. When the system is unbalanced to provide an input force, the resulting motion is shown in Figure 2.

At low speeds, when the spring stiffness is dominant, the motion is in the direction of the unbalance force F (push on a spring and it moves in the direction of the force). It is determined by the ratio $\frac{F}{K}$, where K is the spring stiffness.

At resonance, when the spring and mass stiffnesses cancel, the motion lags the force by 90º (against the direction of rotation). The motion is in quadrature to the force and is determined by the ratio $\frac{F}{D(1-\lambda)\Omega}$, where $D(1\text{-}\lambda)\Omega$ † is the fluid wedge (tangential or cross-coupled) portion of the dynamic stiffness (push on a wedge and it moves at right angles to the force).

At high speeds, when mass stiffness is dominant, the motion lags the force by 180º (a track and field athlete swinging a hammer uses his mass to balance the system by moving away from the weight). The motion is determined by $\frac{F}{M\Omega^2}$, where $M\Omega^2$ is the mass portion of the dynamic stiffness.

The general expression for synchronous motion, then, is

$$Motion = \frac{Force}{Restraint} = \frac{Force}{\left(K + D(1\text{-}\lambda)\Omega - M\Omega^2\right)}.$$

† The general Quadrature Stiffness term is $K_Q = jD(\omega - \lambda\Omega)$, where ω is rotor precession rate and λ is the Fluid Circumferential Average Velocity Ratio due to the fluid dragged into rotation by the shaft, which reduces the effect of damping. In this case, $\omega = \Omega$, so that

$$K_{Q\ Synch} = D(1-\lambda)\Omega\ .$$

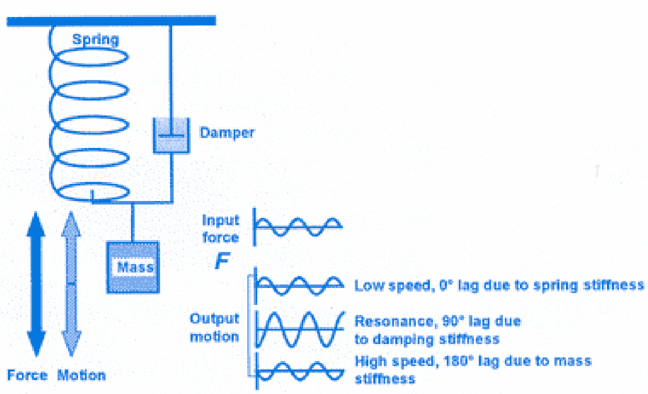

Figure 1
Response of a one-dimensional spring-damper-mass system to an oscillating force.

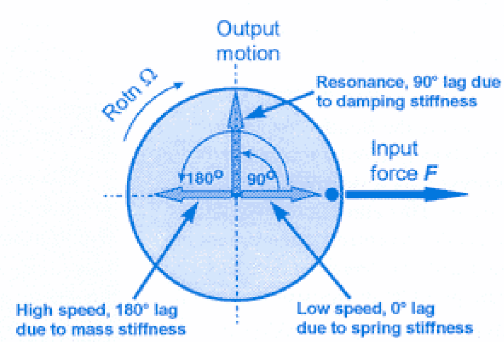

Figure 2
Response of a two-dimensional, rotating spring-damper-mass system to a force rotating Y to X (cw) at the same rate.